PERFORMANCE AND EMISSIONS CHARACTERISTICS OF ALTERNATIVE BIODIESEL FUEL ON 4-STROKE MARINE DIESEL ENGINE

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Special dedicated

to my beloved mother, late father and wife

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ABSTRACT

Alternative fuels for diesel engines have become increasingly important due to several socioeconomic aspects, imminent depletion of fossil fuel and growing environmental concerns. Global warming concerns due to the production of greenhouse gases (GHGs) such as carbon dioxide (CO_2) as results from internal combustion engine have seen as one of major factor the promotion of the use of biofuels. Therefore, the use of biodiesel fuel (BDF) as an alternative for fossil diesel (DSL) is among the effective way to reduce the CO_2 emission since it is classified as green and renewable energy. However, it is acknowledged that the use of BDF is restricted due to loss of efficiency and long term problems upon the engine. Hence, a study focussed on investigating the effects of BDF derived from crude palm oil (CPO), jatropha curcas oil (JCO) and waste cooking oil (WCO) blended with DSL at various blending ratio on engine performance and exhaust gas emissions has been performed. This experimental test was done using a small 4-stroke marine diesel engine which operates through engine speeds stimulated at 800, 1200, 1600 and 2000 rpm under 0, 50 and 90% dynamometer loads integrated with emission gas analyser that attached to the exhaust pipeline. As results of experimental investigations, the increment in performance of torque, brake power, brake thermal efficiency (BTE) and brake mean effective pressure (BMEP) while decrease in brake specific fuel consumption (BSFC) has been observed for CPO and JCO fuels comparative to DSL. Meanwhile a contrariwise outcome was obtained for WCO fuels. In conjunction, CPO and JCO promotes lower carbon monoxide (CO) emissions but signified higher nitrogen oxides (NOx), carbon dioxide (CO_2) and hydrocarbon (HC) emissions compared to DSL. Apart, WCO promotes lower CO, CO_2 and HC emissions but signified higher NOx emissions compared to DSL. It can be concluded that BDF is useable in diesel engines without engine modifications. The outcomes of this study is significantly contributed as a guidence and reference to the local authority in order to evaluate and select the suitable and optimum BDF for development of policies, regulations and standard.

ABSTRAK

Bahan api alternatif bagi enjin diesel semakin mendapat perhatian disebabkan faktor-faktor sosioekonomi, bahanapi fosil yang semakin berkurangan dan meningkatnya kesedaran terhadap penjagaan alam. Pemanasan global akibat penghasilan gas rumah hijau seperti karbon dioksida (CO_2) daripada enjin pembakaran dalam merupakan faktor besar yang mendorong penggunaan bahanapi bio. Maka, penggunaan bahanapi biodiesel (BDF) sebagai alternatif bagi diesel fosil (DSL) merupakan antara langkah efektif untuk menurunkan CO_2 kerana ia diklasifikasikan sebagai tenaga boleh baharu dan bersih. Namun, diketahui bahawa terdapat kekangan dalam penggunaan BDF seperti hilang kecekapan dan kesan jangka masa panjang terhadap enjin. Oleh itu, satu kajian yang fokus kepada mengkaji kesan-kesan campuran DSL dengan BDF yang dihasilkan daripada minyak mentah kelapa sawit (CPO), minyak pokok jarak (JCO) dan minyak masak terpakai (WCO) pada nisbah campuran yang berbeza terhadap prestasi enjin dan gas-gas ekzos yang terbebas telah dilaksanakan. Kajian ini telah disempurnakan menggunakan sebuah enjin diesel marin 4-lejang kecil yang beroperasi pada kelajuan 800, 1200, 1600 dan 2000 ppm di bawah beban dinamometer pada 0, 50 dan 90% serta telah dipasangkan sekali alat penguji gas ekzos pada paip ekzos. Hasil kajian mendapati bahawa terdapat peningkatan terhadap prestasi enjin dari segi daya kilas, kuasa brek, kecekapan terma brek (BTE) dan tekanan min efektif brek (BMEP) manakala berlaku penurunan penggunaan bahan api spesifik brek (BSFC) bagi bahan api CPO dan JCO berbanding DSL. Sementara itu, hasil yang berlawanan diperoleh bagi bahan api WCO. Sebagai kesinambungan, penggunaan CPO dan JCO membebaskan gas karbon monoksida (CO) yang lebih rendah tetapi pengoksidaan gas nitrogen (NOx), gas karbon dioksida (CO_2) dan hidrokarbon (HC) yang lebih tinggi berbanding DSL. Selain itu, WCO membebasan gas CO, CO_2 dan HC yang lebih rendah tetapi NOx lebih tinggi berbanding DSL. Dapat dirumuskan bahawa BDF boleh digunakan dalam enjin diesel tanpa sebarang modifikasi enjin. Hasil kajian ini sangat berguna sebagai panduan dan rujukan pihak berkuasa tempatan dalam menilai dan membuat pemilihan campuran BDF yang sesuai dan optima dalam pembangunan polisi, peraturan dan piawai.

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LIST OF SYMBOLS AND ABBREVIATIONS

%	-	Percentage
^{0}C	-	Degree Celsius (temperature unit)
^{0}CA	-	Degree crank angle
AIST	-	National Institute of Advanced Industrial Science and Technology, Japan
AMP	-	Accumulation mode particles
ANP	-	Agéncia Nacional de Petróleo, Brazil
ASTM	-	American Society for Testing and Materials
ASTM D975	-	American Standards for Testing Materials for diesel fuel
ASTM D6751	-	American Standards for Testing Materials for B100 biodiesel
aTDC	-	After top dead center
ATDC	-	After top dead center
B0	-	100% diesel content
B5	-	5% biodiesel blend with 95% diesel content
B10	-	10% biodiesel blend with 90% diesel content
B15	-	15% biodiesel blend with 85% diesel content
B20	-	20% biodiesel blend with 80% diesel content
B30	-	30% biodiesel blend with 70% diesel content
B40	-	40% biodiesel blend with 60% diesel content
B50	-	50% biodiesel blend with 50% diesel content
B80	-	80% biodiesel blend with 20% diesel content
B100	-	100% biodiesel content
bar	-	Pressure unit
BDF	-	Biodiesel fuel
BHP	-	Brake horse power
BIS	-	Bureau of Indian Standards
BMEP	-	Brake mean effective pressure
BO	-	Bleach oil

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